

1.1 The Heart



Transportation Systems

The human body is made up of trillions of cells closely packed together. These cells are similar to the closely packed houses that make up a city. Each house's inhabitants generate wastes that must be regularly removed, and each house requires a constant supply of water and energy (such as electricity and natural gas). The houses are often far from the source of the needed supply or the waste disposal site. Like houses, cells generate wastes and require constant supplies. An efficient network for transporting materials is required to keep both cells and houses functioning properly. Blood vessels in the human body function very much like highways, roads, and pipes that serve cities and towns. Notice that no home in the photo is far from a road. In your body, no cell is more than two or three cells away from a blood vessel. Like roadways, there are one-way blood vessels, major and minor blood highways, and even the occasional traffic jam as blood vessels break or clog.

The Body's Internal Transportation System

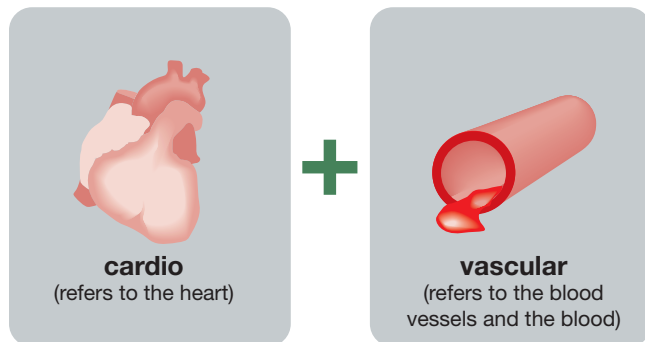
Microscopic organisms and even some larger invertebrates do not need to have an extensive internal transportation system. This is because their cells are in direct contact with the environment, and gases and materials can move to each of the organism's cells through simple diffusion. Similarly, as cities grow larger, a greater number of roadways and services and more complicated networks for transportation are required. The larger and more complex the organism, the greater the need for a more extensive internal transportation network that effectively transports materials to all specialized cells. This internal transportation network is called the **circulatory system** or the **cardiovascular system**.

► **circulatory system or cardiovascular system:**
the system consisting of the heart, blood vessels,
and blood that circulates through the body

The human circulatory system performs four key functions. It

- transports and delivers oxygen and nutrients (e.g., minerals, vitamins, and glucose) to the body's cells in exchange for carbon dioxide and wastes
- transports and delivers chemical messengers—such as hormones—throughout the body
- distributes body heat
- defends against disease

The heart, blood vessels, and blood are the circulatory system's major components. Many people use the term *cardiovascular system* because this name includes the key parts of



By the end of Chapter 1, you will be able to describe the structure and function of the circulatory system and its major parts and examine how the circulatory system facilitates interactions between the human body's blood cells and the external environment. You will also investigate substances that harm the circulatory system and study disorders of the system.

Ideas About the Heart

Some historical ideas about how the heart and circulatory system work may seem strange to some. The ancient Egyptians believed that a person's emotions, wisdom, and personality originated in the heart rather than in the brain. When someone died they believed that the dog-headed god, Anubis, weighed that person's heart to determine his or her fate in the afterlife. Even today, people still use this Egyptian idea of the heart causing emotions by using metaphors like "suffering from a broken heart," "stealing someone's heart," or "speaking from the heart."

In the second century CE, a Greek physician named Galen became very influential as a personal physician to the Roman emperor. He was very interested in observing the functioning of biological systems. Since studying human dissections was not considered acceptable, many of Galen's ideas were based on his studies of animal dissections. This led him to develop misconceptions about human anatomy, including that the heart was split into two chambers, that food was turned into blood by the liver and then used up by the body, and that blood sloshed back and forth like the ocean's tides. Galen also believed that the heart sucked blood in from the veins rather than acting like a pump. Galen's ideas were widely accepted and his misguided teaching influenced beliefs that lasted for an incredible 1500 years!

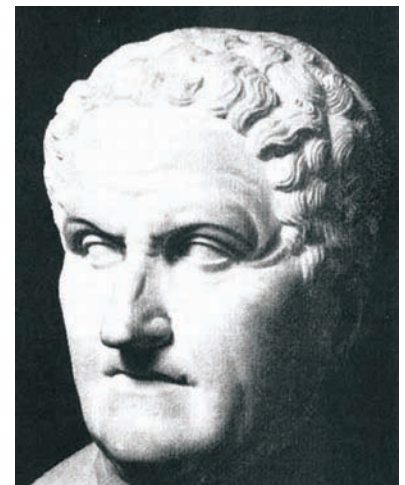
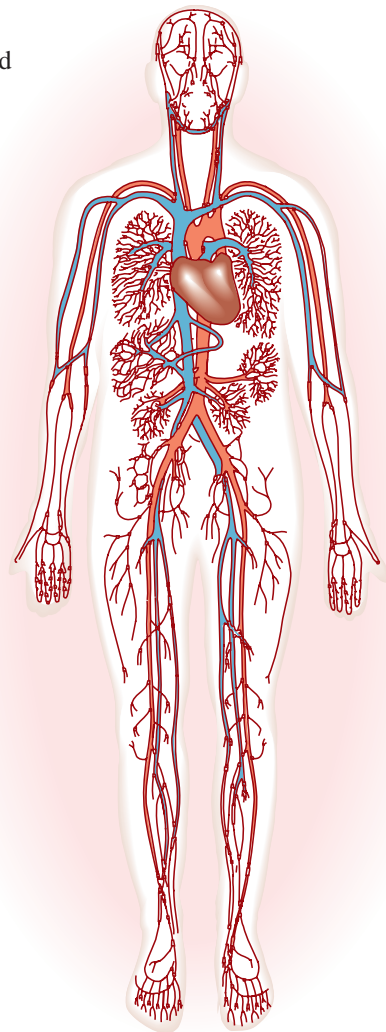
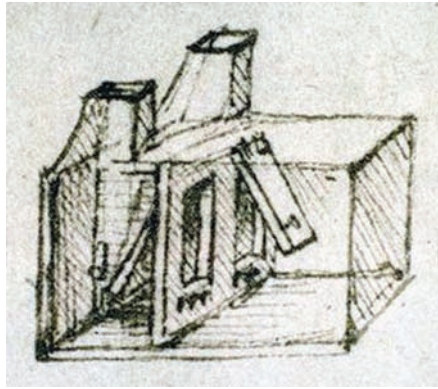


Figure A1.1: Galen

Leonardo da Vinci

In the late fifteenth century, Leonardo da Vinci, the famous Renaissance artist, inventor, and scientist began examining many human cadavers and made accurate and detailed drawings of the heart and circulatory system. Da Vinci made careful records of his observations, often comparing the human body to a machine. One of his drawings compares the human heart, with its chambers, to a furnace. Experimentation and investigation on human cadavers was discouraged at the time and some of

da Vinci's findings contradicted the beliefs and teachings of that era. To keep his work secret and to prevent other people from stealing his ideas, he used his own special shorthand mirror image writing. Perhaps if circumstances had permitted Leonardo da Vinci to share and publish his work, a more complete understanding of the heart and its functions would have been available to Renaissance-era physicians.



William Harvey

In the 1600s the physician William Harvey began to seriously question the teachings of Galen. Findings based on Harvey's studies of human anatomy and dissections of human cadavers disagreed with Galen's well-established theories. Harvey found that there were valves in both the heart and the veins that kept blood moving in one direction—not sloshing like ocean tides as Galen believed. By using simple mathematical calculations, Harvey took the volume of blood that the heart could hold and multiplied that volume by the number of times the heart beat per minute. This calculation resulted in a value far greater than the amount of fluid the body could hold. Harvey concluded that the heart must be re-pumping the same blood. This experiment contradicted Galen's idea that the liver was turning food into new blood to be used up by the body. Because Harvey was not able to explain how blood got from the arteries to the veins, his theory was not immediately accepted.

A few years after Harvey's death, Marcello Malpighi used a microscope to discover the tiny hair-like capillaries that connect arteries to veins. This confirmed Harvey's theory that a small volume of blood was constantly circulated to all parts of the body and that the heart, arteries, and veins were connected in a circulatory system.

At the centre of Harvey's work were simple calculations relating to the volume of blood and the heartbeat. Today, similar calculations can reveal amazing information about the effectiveness of the heart as a pump. The heart of a typical adult human male pumps out 70 mL of blood per beat. This is called stroke volume. The stroke volume for a typical adult human female is about 60 mL per beat. The average resting heart rate for men and women is around 72 beats per minute. So, if you know the volume of blood pumped in each beat and the number of beats that occur in a minute, you can determine the volume of blood pumped by the heart in one minute. This value is called the **cardiac output**.

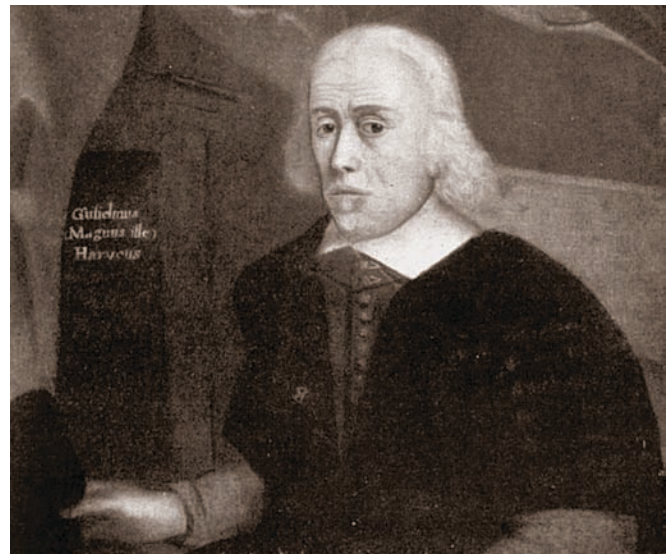


Figure A1.2: William Harvey

cardiac output: the volume of blood pumped by the heart in one minute, which is equal to the product of stroke volume and heart rate

Example Problem 1.1

A typical human male has a stroke volume of 70 mL per beat and a resting heart rate of 72 beats per minute.

- Calculate the cardiac output. Express your answer in litres per minute.
- Calculate the volume of blood that would be pumped in one day based upon the cardiac output.

Solution

- a. stroke volume = 70 mL/beat

$$= 70 \cancel{\text{mL}}/\text{beat} \times \frac{1 \text{ L}}{1000 \cancel{\text{mL}}} \\ = 0.070 \text{ L/beat}$$

heart rate = 72 beats/minute

cardiac output = ?

$$\text{cardiac output} = (\text{stroke volume}) \times (\text{heart rate})$$

$$= \frac{(0.070 \text{ L})}{\cancel{\text{beat}}} \times \frac{72 (\cancel{\text{beats}})}{\text{min}} \\ = 5.04 \text{ L/min} \\ = 5.0 \text{ L/min}$$

The cardiac output is 5.0 L/min.

Note: It is often best to handle the conversion of units when listing the data. The final answer is rounded to two significant digits since the given values are expressed to two significant digits.

b. volume pumped in one day = $\frac{(5.04 \text{ L})}{\cancel{\text{min}}} \times \frac{(60 \cancel{\text{min}})}{1 \text{ h}} \times \frac{(24 \cancel{\text{h}})}{1 \text{ d}} = \frac{7257.6 \text{ L}}{\text{d}} = 7.3 \times 10^3 \text{ L/d}$

Note: The unrounded value from a. is used in the follow-up calculation in part b. Since the original given values were expressed to two significant digits, the final answer should be rounded to two significant digits. In this case, scientific notation is required, unless the answer is expressed in kL.

Practice

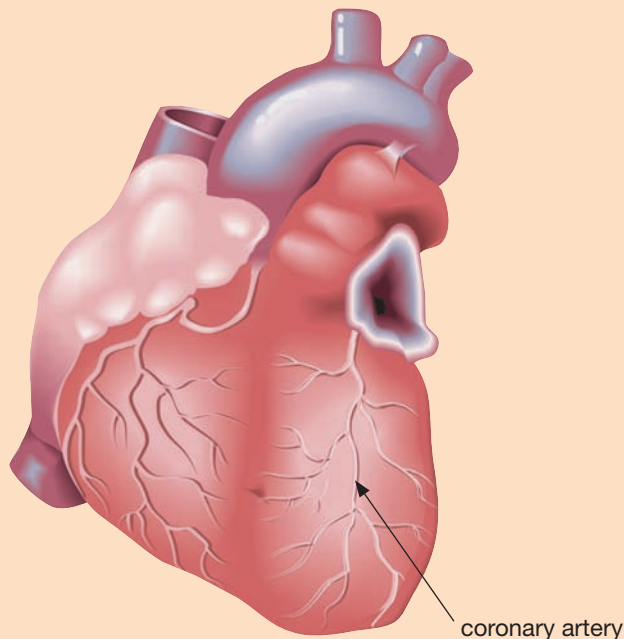
- Copy and complete this table. In the middle column, summarize each person's different historical theories about the heart and circulatory system. Each of the three listed individuals contributed at the time to the understanding of the heart and circulatory system. In the right column, describe the limitations of each theory or contribution.
- A female Science 30 student has a resting heart rate of 68 beats per minute. Determine her cardiac output in litres per minute.
- Refer to your answer from question 2. How much blood would this student's heart pump in one year if it maintained the resting heart rate?
- The average human has approximately 5 L of blood. How long does it take the heart to pump this volume?
- If a male raised his heart rate to 180 beats per minute through intensive exercise, such as running on a treadmill, how much blood would his heart pump per minute? Assume that the stroke volume remains at 70 mL per beat.
- A rain barrel holds approximately 213 L of water. This same volume could fill more than 100, 2-L pop bottles.
 - Determine your resting heart rate using the techniques from "Try This Activity: Measuring Your Heart Rate Before and After Exercise." Use this value to calculate your cardiac output.
 - If you had a pump working at the same rate as your cardiac output, how long would it take to fill a 213-L barrel?
 - Suppose your heart rate doubled its resting value because you were exercising. How long would it take your pumping heart to fill the same barrel under these circumstances? Assume the stroke volume remains constant for all parts of this problem.

HEART THEORIES

Person	Theory About the Heart	Limitations of the Theory
Galen		
Leonardo da Vinci		
William Harvey		



Include your cardiac output in your health file.



The Heart: An Amazing Pump

Clench your hand into a fist. The size of your closed hand corresponds approximately to the size of your heart. Now squeeze your hand and relax it. Imagine doing that action about every second. That would add up to over 80 000 times per day and 2.5 billion times in an average lifetime! This squeezing—called contracting—and relaxing is exactly what your heart does every day.

Like any other muscle that is contracting, the heart needs a constant supply of oxygen and other nutrients. Since the entire body depends upon the heart, the first organ that the heart supplies with oxygen-rich blood is itself. The blood vessels that supply the heart are called the **coronary arteries**.

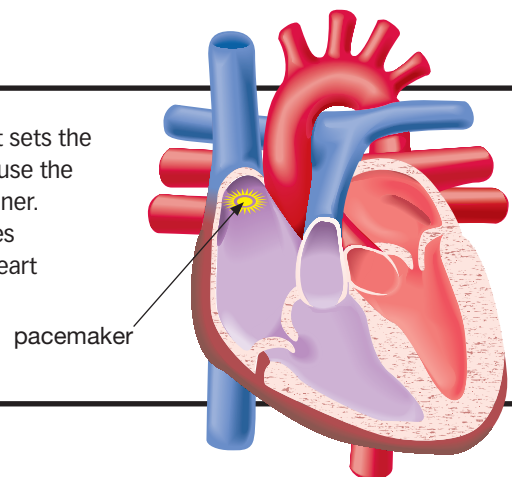
► **coronary arteries:** the vessels that supply the heart muscle with oxygen-rich blood



DID YOU KNOW?

The pacemaker is a small region of specialized muscle tissue that sets the tempo of the heartbeat. The pacemaker generates electrical signals that cause the muscle fibres in the heart to simultaneously contract in a co-ordinated manner. If one muscle fibre of a heart chamber is stimulated to contract, all the fibres of that chamber contract in unison. This en masse contraction makes the heart muscle unique.

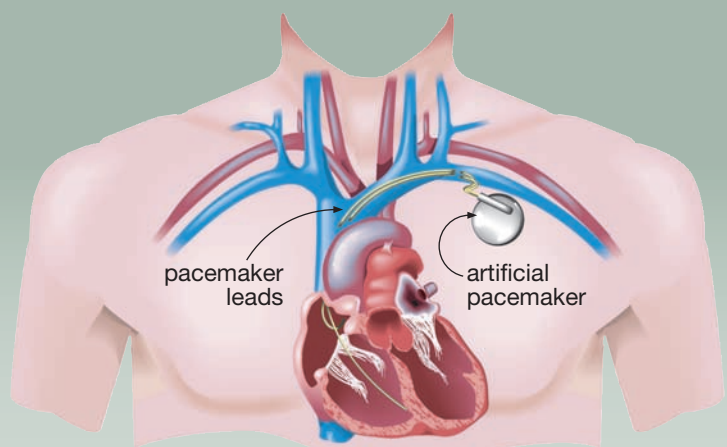
If the heart's pacemaker cells are unable to regulate a steady heartbeat, then an artificial pacemaker can be surgically implanted.



Science Links

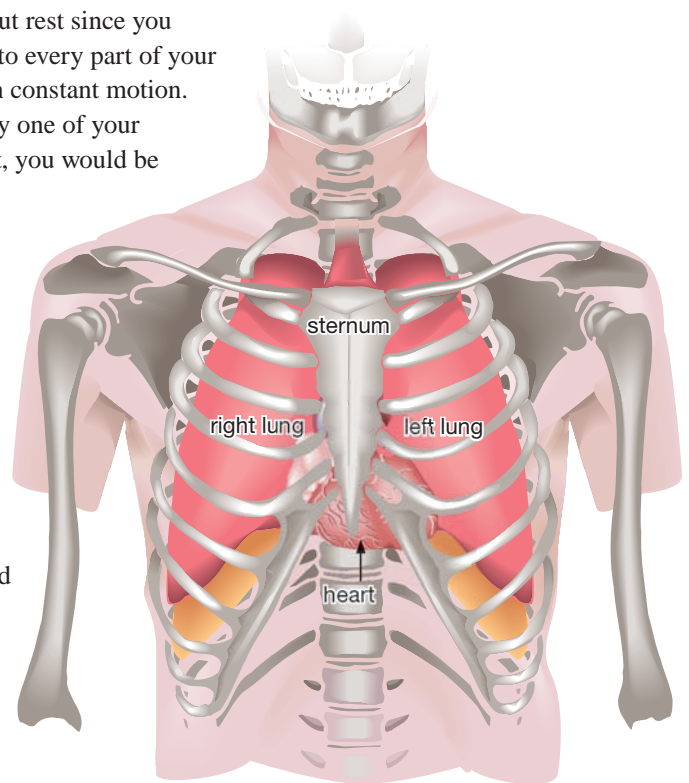
An artificial pacemaker is a small battery-operated machine that sends electrical signals to the heart through tiny wires. This little computer “listens” to the heart and supplements its normal rhythm. Adjustments to the pacemaker can be made without further surgery by using radio-wave signals. These signals are sent through the skin and other tissues to the artificial pacemaker from a control wand outside of the body.

In Unit C you'll learn more about radio waves as well as devices that both produce and transmit electrical energy.



Your heart is a muscular pump that has been beating without rest since you were a developing embryo, and it will continue to push blood to every part of your body until the end of your life. All the blood in your body is in constant motion. With each powerful heartbeat, life-giving blood is sent to every one of your approximately 60 trillion cells. Without the work of your heart, you would be dead in a matter of minutes.

When you imagine a heart you might think of the familiar shape that children learn to draw in preschool, but the shape of the human heart is really more like an upside-down pear with four open spaces, or chambers, inside. Since the heart is a muscle, its look and texture is like that of the red meat you would see in a raw steak. Contrary to the popular belief that the heart is found on the left side of the chest, the heart is actually located almost in the centre of the chest where it is protected by the hard sternum (or breastbone). During a medical checkup, the doctor listens on the left side with a stethoscope because the heart is pointed slightly to the left, and sounds produced by parts of the heart are easier to hear there.



Anatomy of the Heart

Study the labelled diagram of the human heart in Figure A1.3. Note that the areas containing oxygen-rich blood are shaded red and the areas containing oxygen-poor blood are blue.

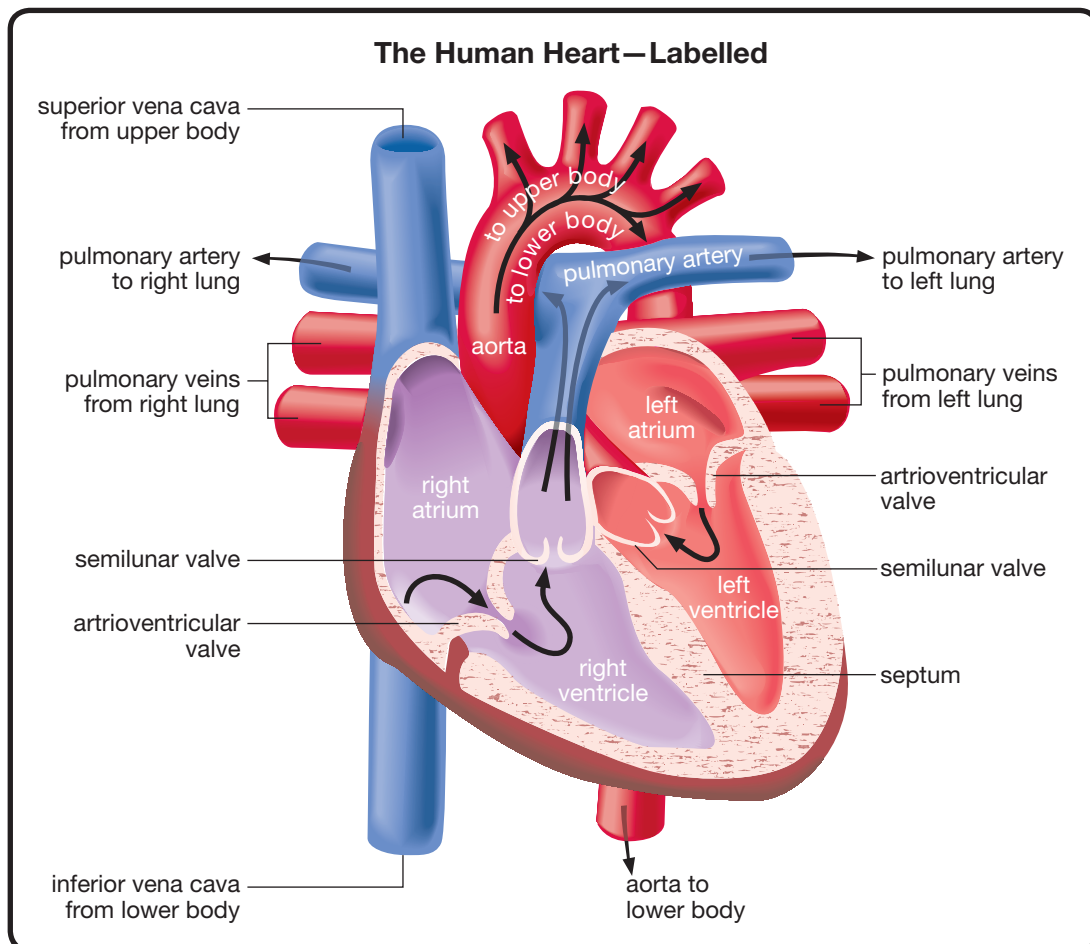


Figure A1.3

Do you notice that the human heart in Figure A1.3 seems to have the left and right mixed up? That's because heart diagrams are labelled from the point of view of the person who has the heart. If this heart was in the person who was facing you, this is how this person would label left and right.

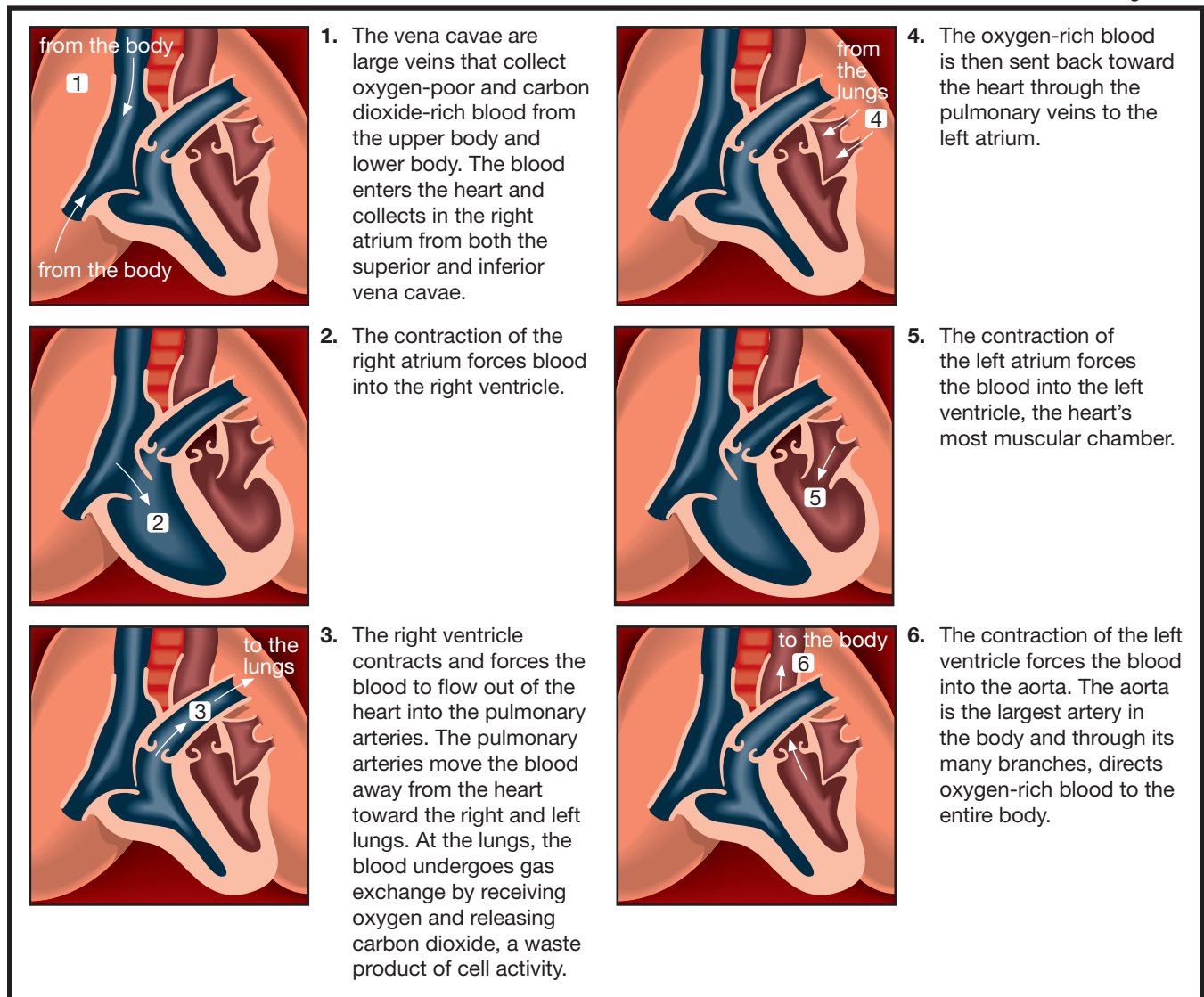
You probably also noticed that the heart is unevenly split into four chambers. The right and left sides of the organ are partitioned by a thick wall called the **septum**. The smaller top two chambers are the left **atrium** and right atrium, together called atria. The bottom two pointed chambers are the left **ventricle** and right ventricle. The left ventricle is slightly bigger in size because its job is to pump oxygen-rich blood to most of the body. The four chambers are divided by **heart valves** that ensure blood will travel in only one direction through the heart. The valves between the atria and the ventricles are held in place by string-like tendons that act like the ropes on a drawbridge. These tendons help ensure the proper alignment of the valves when they are closed.

- ▶ **septum:** a thick wall of muscle that divides the left and right sides of the heart
- ▶ **atrium:** the smaller upper chamber that receives blood returning to the heart
- ▶ **ventricle:** the larger v-shaped bottom chamber that pumps blood from the heart
- ▶ **heart valves:** thin flaps of tissue in the heart that open and close to ensure the proper direction for blood flow

Blood Flow Through the Heart

Since blood circulates constantly through the body, you could begin to trace the flow of blood at any point. In Figure A1.4, blood's path is traced in a step-by-step manner starting with the place where blood first enters the heart on its way back from the body.

Figure A1.4



Practice

7. Obtain the handout “The Human Heart” from the Science 30 Textbook CD. Attempt to answer the following questions without referring to Figure A1.3. After you have completed as much as you can, use the diagrams in the textbook to complete and/or correct your work.

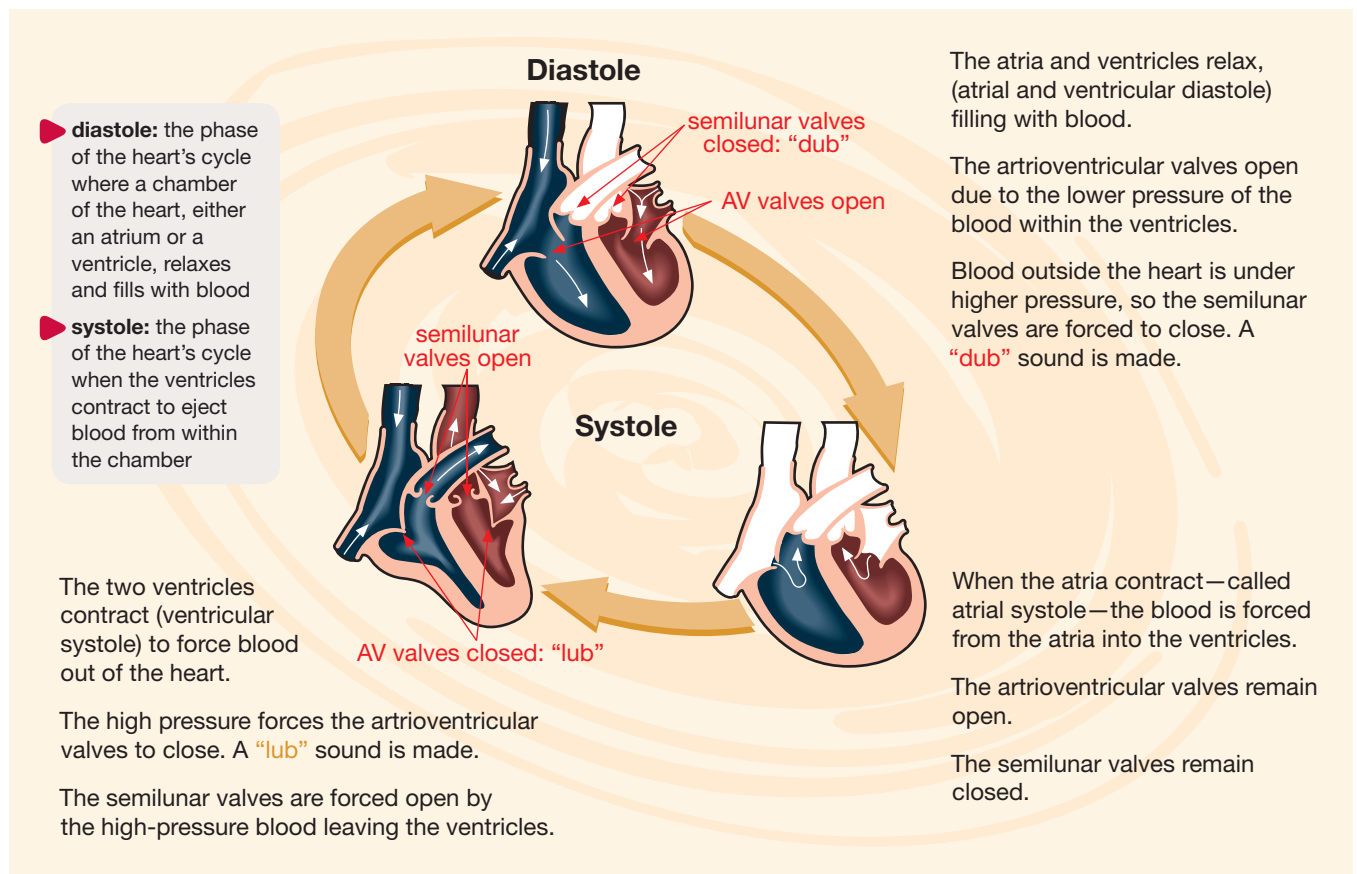


- Add a label for each of the areas identified on this diagram.
- Add red shading to the areas that deal with oxygenated blood and blue shading to the areas that deal with deoxygenated blood.
- Add arrows to indicate the direction of blood flow through each of the chambers and major blood vessels.
- Add the numbers 1 through 6 to outline the sequence for the path of a blood cell as it travels through each of the heart chambers. Begin with number 1 representing the place where blood first enters the heart on its way back from the body.

Heartbeat

You have so far traced the step-by-step flow of blood through the heart, but the action of the heart does not work in steps. Blood does not move through one chamber while the other chambers lay empty waiting for their turn to move the blood on; instead, the two sides of the heart fill at the same time and act together like parallel pumps. Once filled with blood, both atria contract at the same time, followed by the simultaneous contraction of both ventricles. Before the contraction of the ventricles occurs, they are relaxed and the valves between the atria and ventricles are open. This allows blood to flow in and fill the ventricular chambers. This relaxation part of the cycle is called the **diastole**. In the first step of a two-step contraction, the atria contract together to push the blood down into the ventricles. In the second step, the two ventricles contract to force the blood out of the heart. This two-part contraction of the heart cycle is called the **systole**. The “lub-dub” heart sound that a doctor listens for through a stethoscope is due to the heart valves functioning during diastole and systole.

One complete contraction (systole) and one complete relaxation (diastole) combine to make a heartbeat—one cycle of the heart’s activity.



Utilizing Technology

The Animated Heart

Purpose

You will have an opportunity to observe the systole and diastole phases of the heart's cycle by using the applet "The Human Heart." This applet is located on the Science 30 Textbook CD.



Science Skills

✓ Analyzing and Interpreting

Procedure

step 1: Select "Human Heart." Then scroll to "Heart Parts." Practise naming each part of the heart, and then move the cursor over each part to confirm your prediction.

step 2: Select the applet part called "Animated Heart." Carefully watch this animation. Focus on the action of the valves. As the animation plays, add a soundtrack by saying "lub" and "dub" at the correct times. Adjust the heart rate and observe the differences in your spoken sound track.

step 3: Select the part called "Narrated Tour." Locate the position of your own heart as you listen to the description.

Analysis

Computer animations can demonstrate complex processes in ways that are clear and easy to understand. However, compromises are made in terms of which details are included and which ones are omitted. Watch the computer animation again as you answer the following questions.

1. Which details of the systole part of the heart's cycle are included? Which are omitted?
2. Which details of the diastole part of the heart's cycle are included? Which are omitted?
3. If a person has a heart rate of 72 beats/min, then one heartbeat lasts 0.83 s. In other words, the entire heart cycle of diastole, atrial systole, and ventricular systole occurs in just 0.83 s. On average the diastole lasts for 0.4 s and the ventricular systole lasts for 0.3 s, which only leaves about 0.1 seconds for the atrial systole.

Use this information to suggest an explanation for the trends you identified in your answers to questions 1 and 2.



DID YOU KNOW?

When a doctor listens to a patient's heart with a stethoscope, sometimes swishing or whooshing sounds—called *heart murmurs*—are heard in addition to the standard "lub-dub" of the heartbeat. Heart murmurs result from the turbulent flow of blood through the heart—this is why they can sound like water rushing through the end of a garden hose.

Pediatricians classify most heart murmurs they hear as *innocent*, because they are not associated with a heart disease or abnormality. Most children will have a heart murmur at some time, but these innocent murmurs usually disappear by the time they become adults.

The doctor may decide that the characteristics of a particular heart murmur require additional testing to determine if there is an underlying problem with blood flow through the heart. In these cases, the murmur is usually due to the abnormal functioning of a heart valve. A valve may not be closing tightly—it may be too narrow or too stiff. A treatment plan is then designed to address the specific condition.



Factors Affecting Heart Rate

Many factors can affect your heart rate. From your own experiences you know that emotions, such as fear or excitement, quickly increase the heart rate. At one time, you have probably been so scared that it felt like your heart was going to jump out of your chest. Changes in external temperature also can cause your heart rate to change. For example, if you sit in a hot tub, the external temperature of your body increases greatly and the heart must work harder to pump blood around in an attempt to dissipate body heat through the skin.

If training with weights can make a muscle like your bicep larger, can other forms of exercise make your heart larger?

Exercise that improves your heart's ability to provide working muscles with oxygen is called cardiovascular training, or aerobic exercise. Examples include swimming, running, or cycling. In each case, the exercise is done non-stop at a moderate rate for at least 20 minutes. These activities are commonly called cardio workouts because they increase the demand of the body's muscles for oxygen. Cardio workouts, therefore, cause the heart to increase the volume of blood it pumps every minute, elevating the heart rate above its resting value.

The effect of a lifestyle that includes cardiovascular exercise is that the heart and surrounding blood vessels do not become larger; but, instead, these tissues improve in their stretching ability. If the heart muscles are more elastic they have a greater capacity to expand, thus increasing the amount of blood pumped during each heartbeat. These improvements to elasticity translate to an increased stroke volume both when the heart is put under peak demand and when it is resting. This is why people who engage in a lot of cardiovascular exercise develop hearts that need to beat less often to circulate the same amount of blood. A stronger heart is not a larger heart, but is instead a more elastic one. Athletes tend to have a lower-than-average resting heart rate—often only 45 to 50 beats per minute.



Utilizing Technology

Heart Rate Monitoring

Athletes often record their heart rates immediately after waking and record this data for an extended period of time. This technique gives them more accurate resting-heart-rate data because there are probably fewer external variables first thing in the morning—such as diet, caffeine, or exercise—that could affect the heart rate. Increases in the morning resting heart rate could indicate the onset of illness or a lack of recovery from overtraining.

Purpose

For two weeks you will record your resting heart rate and the minutes spent in physical activity every day.

Procedure

step 1: For two weeks you will record your resting heart rate before you get out of bed, and you will also note the approximate minutes spent in physical activity for each day. Physical activity could include walking, participation in sports, dancing, or movement associated with chores or a job such as carrying or lifting.

step 2: Organize your data using a spreadsheet. Use the spreadsheet to create graphs that summarize your results.

Analysis

1. Did you notice any significant changes within the resting-heart-rate data? Were these changes related to the onset of an illness or to a sudden change in the level of physical activity?
2. Compare your findings with those of other students. Is there evidence to support the idea that individuals who regularly participate in cardiovascular exercise tend to have a lower resting heart rate? Why is this question difficult to answer?

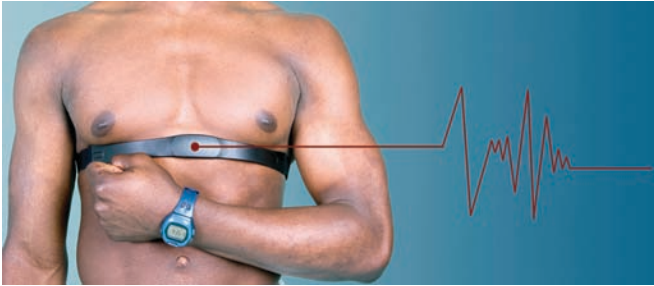


Science Skills

- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communication and Teamwork

Target Heart Rate for Exercise

A chest-strap heart-rate monitor is often used to help ensure that the wearer is exercising at a desired level. Once your heart exceeds approximately 85% of its maximum heart rate, your body burns less fat and produces more lactic acid, which causes muscle soreness. One way to estimate your maximum heart rate is to subtract your age from 220.



It is important to realize that this method of determining your maximum heart rate is just a guideline. Some medications, especially those related to the heart, require a lower maximum heart rate be used than the one provided by this guideline. If you have a chronic medical condition or have any doubts about whether a medication you are taking affects your maximum heart rate, contact your physician to determine your maximum heart rate.

Target Heart Rates	
Personal Health Goal	Percentage of Maximum Heart Rate
maintain fitness level	50 to 60%
increase fat burning or weight loss	60 to 70%
increase cardiovascular endurance	70 to 80%

The maximum heart rate is an important value because it helps provide a guide for goals that you may have for either maintaining or improving your health. A common mistake that people make is that they begin a new exercise program with activities that cause their heart rate to be too high. The best approach is to pace yourself by beginning with activities that will only push you to about 50% of your maximum rate. This is especially important if you have had an inactive lifestyle. You can then gradually increase the intensity of your workouts over the first months of your program. It is always a good idea to consult with your physician if you are just starting a new exercise program or if you have questions about health or fitness.

Practice

- Determine your maximum heart rate by subtracting your age from 220.
- Use your answer from question 8 to complete the following table.

Your Target Heart Rate	
Personal Health Goal	Heart Rate
maintain fitness level	
increase fat burning or weight loss	
increase cardiovascular endurance	

- Describe how your answers to question 9 will change as you get older.



Add your maximum heart rate and your target heart rate for different health goals to your health file.



DID YOU KNOW?

The most effective cardiovascular fitness programs involve activities that are done for at least twenty minutes four or five times a week at moderate activity levels. If you make walking your primary means of transportation, you can build a fitness routine into your day without having to join either a gym or a health club. As is the case with any fitness programs, the best approach is to build regular walking into your weekly routine, to gradually increase the intensity, and to include warm-up and cool-down stretches.



Investigation

Dissecting a Mammal's Heart

Purpose

You will identify the main parts of a dissected heart, and you will trace the path of oxygenated and deoxygenated blood through the heart. You will choose one of two possible pathways for this activity: one that uses instruments to dissect the heart of a mammal; and the other that involves a virtual dissection.



Science Skills

- ✓ Performing and Recording
- ✓ Analyzing and Interpreting

Part A: Using Dissecting Instruments and a Mammalian Heart

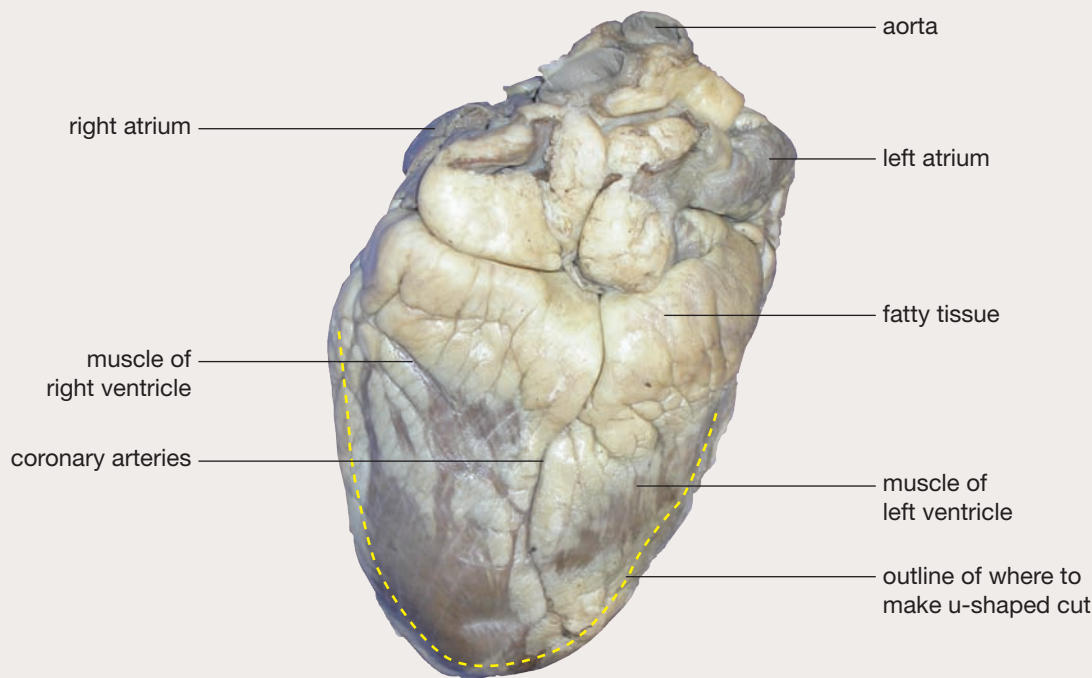
Materials

- heart of a mammal (pig, sheep, or cow)
- set of dissecting instruments—scalpel, scissors, probe, pins
- 2 pieces of yarn 40-cm long, one red and one blue
- handouts “Labels for the Parts of the Heart” and “The Human Heart—Labelled” from the Science 30 Textbook CD
- dissecting tray
- latex or vinyl gloves
- goggles
- apron
- digital camera



Procedure

step 1: Place the heart in front of you with the largest blood vessel—the aorta—at the top of the heart and facing the bottom of the dissecting tray. Notice the presence of a diagonal line of blood vessels, going from the upper left to the lower right on the outside of the heart. These are the coronary arteries that supply the heart itself with blood. These vessels are often surrounded by some fatty tissue.



Confirm that you have the heart oriented properly by feeling each half of the heart on either side of the coronary artery with your hand. The heart's left side should feel thicker and more muscular than the heart's right side. **Remember:** The heart's left side is on your right as you look at the heart.

- step 2:** Begin by making a u-shaped cut around the sides of the heart to make a “flip-top” heart. Carefully hold the scalpel parallel to the table top as you cut. Be sure not to completely cut the heart into two separate sections. You should end up with a “flip-top” heart. This allows the interior of the heart to be observed and also to be put back together for later in this activity.
- step 3:** Lift the upper side of the heart away to reveal its inner chambers. Identify the side of the heart with the thicker-walled chambers. This is the heart’s left side. Orientate the heart so the heart’s left side is on your right.
- step 4:** Using your finger or a dissecting probe, locate where the blood enters the right atrium (vena cava). Blue yarn can be used to simulate the pathway in which deoxygenated blood flows. Thread a piece of blue yarn through the vena cava into the right atrium and then through the atrioventricular valve into the right ventricle.
- step 5:** Use your finger or probe around to find out where the blood must exit the right ventricle through the semilunar valve into the pulmonary artery. Remember that the blood cannot go back through the one-way valve or across the septum, which forms a barrier between the heart’s right and left sides. Thread the blue yarn from the right ventricle to the pulmonary artery.
- step 6:** Tie a piece of red yarn to the blue yarn to simulate that the blood has become oxygenated in the lungs. Use the red string to trace the pathway that oxygenated blood flows through the pulmonary veins, to the heart’s left side, and out through the aorta.
- step 7:** Obtain the handout “Labels for the Parts of the Heart” from the Science 30 Textbook CD. Cut out each of the labels and use dissection pins to attach the labels to the corresponding parts of the heart. If you are uncertain, use the “The Human Heart—Labelled” handout to help you identify the major parts of your dissected heart.
- step 8:** Have your teacher check your labelled heart.
- step 9:** Take a digital photograph of your dissected heart, complete with all the labels pinned in place.



Part B: Using a Computer Applet

Procedure

Locate the virtual version of “Dissecting a Mammal’s Heart” on the Science 30 Textbook CD. Follow the directions on the applet as you complete your virtual dissection.



1.1 Summary

Beliefs about the heart and the circulatory system have changed over time. William Harvey was the first person to prove that blood circulated around the body in a closed system of vessels. The pump that drives the circulatory system is the heart. The output of blood from the heart depends on how many times the heart contracts and how much blood it moves with each contraction. The atria contract simultaneously, followed by the simultaneous contraction of the two ventricles. This two-part contraction creates a “lub-dub” sound due to the functioning of the heart’s valves.

The heart rate is affected by emotion, temperature, exercise, fitness level, sleep, hormones, chemicals, drugs, and alcohol. By monitoring the heart rate during exercise programs, appropriate levels of exertion can be ensured. Heart rate is a key indicator of cardiovascular fitness.



1.1 Questions

Knowledge

- Beginning with the vena cava, indicate the order of the following structures of the cardiovascular system through which blood flows: left atrium, right ventricle, lungs, body, right atrium, left ventricle, aorta.
- Refer to Figure A1.5. Match the numbered structures on the heart to the part of the heart that
 - receives oxygenated blood from the lungs
 - sends oxygenated blood to the body
 - prevents the backflow of blood in the heart
 - separates the right and left halves of the heart
 - collects deoxygenated blood from the body

Applying Concepts

- If an Olympic athlete has an increased stroke volume of 100 mL, calculate his cardiac output at rest (50 bpm), with light exercise (115 bpm), and with high-intensity exercise (180 bpm). Assume the stroke volume remains constant.
 - Explain why you expect the athlete to have a lower resting heart rate than a person with an inactive lifestyle.
- Why are the walls of the heart’s right ventricle thinner than the walls of the heart’s left ventricle?
- Compare the systole and diastole portions of the heart cycle.
- Describe the purposes of a chest strap or other type of heart-rate monitor when a person is exercising.

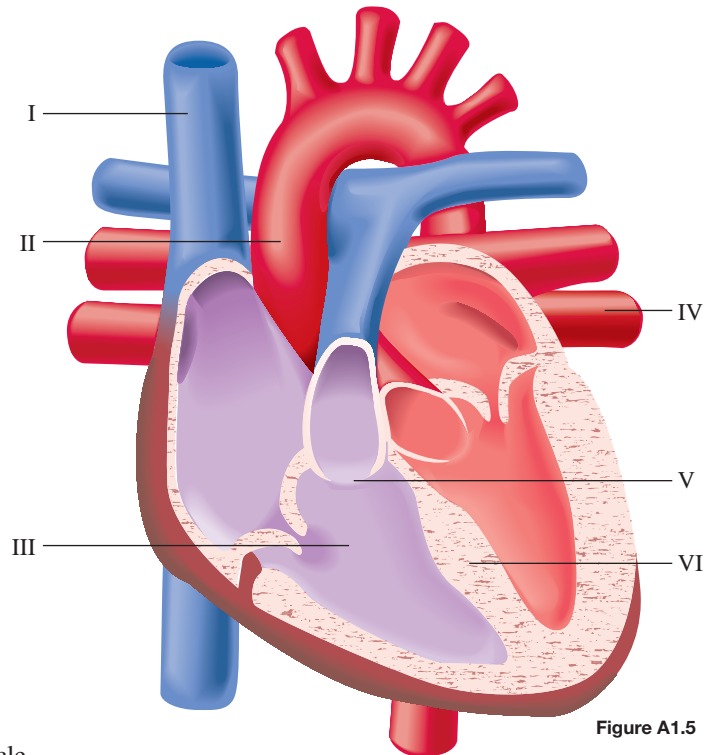


Figure A1.5